

FINAL

**PERCHLORATE (ClO₄) TREATMENT TECHNOLOGIES LITERATURE REVIEW
OPERABLE UNIT 1 EXPANDED TREATABILITY STUDY**

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Table F-1. Selected Ex Situ Biological Treatment Case Study Results

Author	Scale	Reactor Type	Media Type	Reactor Size	HRT	Total Flowrate	Amendments	Initial [Final] ClO ₄ ⁻ Levels	Initial [Final] Nitrate Levels
ESTCP, 2000	P	CSTR	NA	1,600 gal and 720 gal	18 to 24 hrs	NA	Brewers Yeast Extract	4,000 to 10,000 mg/L [<0.5 mg/L]	346 to 4,622 mg/L
ESTCP, 2000	F	CSTR	NA	1,600 gal and 720 gal	10 to 20 hrs	450 gpm	Carbohydrate By-product	300 to 4,600 mg/L [4 to 400 µg/L]	5,000 mg/L
Hatzinger et al., 2002	P	FBR	GAC	15 ft tall by 20 dia	NA	30 gpm	Ethanol	770 µg/L [<4 µg/L]	33.2 mg/L [<0.4 mg/L]
Hatzinger et al., 2000	F	FBR	GAC	4 Units 22 ft tall by 14 ft dia	12 min	4,000 gpm	Ethanol	4,000 to 6,000 µg/L [<4 µg/L]	6.5 mg/L [<0.4 mg/L]
Guarini, 2002	F	FBR	GAC	1 Unit 21 ft tall and 5 ft dia	NA	50 gpm	Acetic Acid	15,000 µg/L [<4 µg/L]	1.9 mg/L
Togna et al., 2001	L	FBR	GAC	4 L	NA	NA	Acetic Acid and Ethanol	25,000 µg/L [<5 µg/L]	1.9 mg/L
Evans et al., 2002	P	PBR	Plastic and Sand Modules	7 ft tall by 2 ft ² x-section	NA	1 to 2 gpm	Acetic Acid	75 µg/L [<4 µg/L to 4.8 µg/L]	4.3 mg-N/L [NA]
Perlmutter et al., 2000	P	PBR	Bio-Rings (3/4 to 2")	2,600 gal 5-ft dia and 18 ft tall	60 min	43 gpm	Acetate	23,000 µg/L [<20 µg/L]	NA
Perlmutter et al., 2000	L	PBR	Sand	2.2 gallons	30 to 80 min	20 to 80 mL/min	Acetate	1 to 5 mg/L [<20 µg/L]	NA
Perlmutter et al., 2000	L	PBR	Plastic Beads	2.2 gallons	20 to 130 min	25 to 160 mL/min	Acetate	1 to 5 mg/L [<20 µg/L]	NA
Perlmutter et al., 2000	L	PBR	Bio-Rings (5/8")	2.2 gallons	45 to 300 min	25 to 160 mL/min	Acetate	1 to 5 mg/L [<20 µg/L]	NA
Wallace et al., 1998 ^a	L	PBR	Diatomaceous Earth Pellets	1.2 m tall by 7.6 cm in dia	0.5 to 1 hr	NA	Brewers Yeast Extract	1,500 mg/L [<100 mg/L]	NA
Logan and Kim (1998) ^a	L	PBR	Sand	14.2 cm tall	NA	NA	Acetate	20 mg/L [<4 µg/L]	NA
Giblin et al., 2000	L	PBR	Diatomaceous Earth Pellets	120 mL 18 cm tall by 3.5 cm dia	2 hrs	1 mL/min	Hydrogen and Bicarbonate	740 µg/L [<4 µg/L]	NA
Giblin et al., 2000	L	PBR	Diatomaceous Earth Pellets	NA	NA	1 mL/min	Acetate	738 µg/L [<04 µg/L]	NA
Van Ginkel et al., 1998 ^a	L	Gas-Lift Reactor	Pumice	NA	6 hrs	NA	Hydrogen Gas	>95% chlorate removal	NA
Rittmann et al., 2002	P	Hollow Fiber	Composite Membrane	13 m ² surface area	NA	NA	Hydrogen Gas	60 µg/L [3 µg/L]	24 [<0.5 mg/L]

HRT= hydraulic residence time

PBR = packed bed reactor

FBR = fluidized bed reactor

CSTR= continuously stirred tank reactor

NA = not applicable.

(a) Source: Logan, 1998.

(b) Source: Perlmutter et al., 2000.

